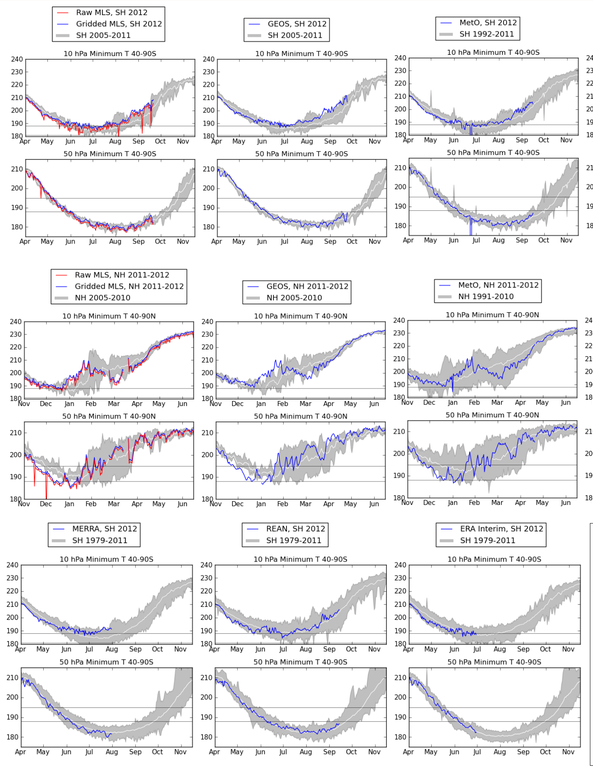
Polar Vortex and Temperature Diagnostics for Intercomparisons and MLS Data Inspection: Update on Antarctic 2012 Meteorology in Relation to Incoming MLS Data

Zachary Lawrence (1), Gloria Manney (2,1), Ken Minschwaner (1)

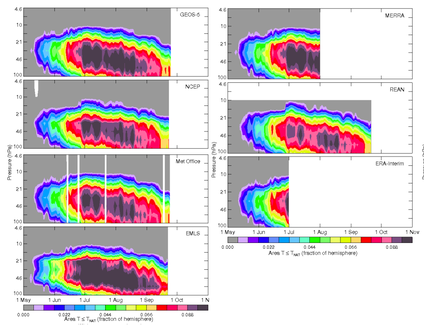
[1]New Mexico Institute of Mining and Technology; [2]NorthWest Research Associates



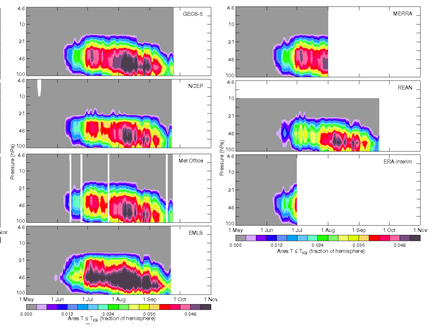
Plots shown are timeseries of minimum daily temperatures for polar winters. Blue curves show the most recent mins. Grey envelopes represent the range of min temps over all previous years, with the averages shown in white. Black lines indicate the approximate formation temps for PSCs (NAT & ICE respectively).

- MLS plots have red curves representing the raw data obtained along orbit tracks; blue curves represent data mapped to a uniform lat/lon grid.
- All datasets show similar temporal variation.
- SH mins are constrained within a much smaller envelope, indicating much larger interannual variability in the NH.
- NH mins at 50mb are 5-10K higher than those in the SH for all datasets.

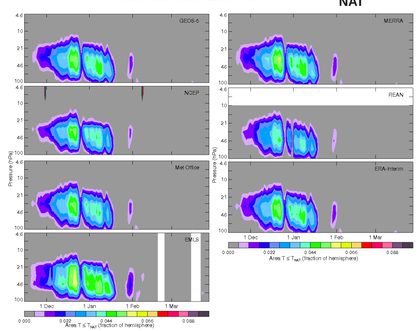
2012 SH $T < T_{NAT}$



2012 SH $T < T_{ICE}$



2011-2012 NH $T < T_{NAT}$



Plots shown represent time series of the fraction of each hemisphere where temps are less than the formation temps for NAT (left) & ICE (right) PSCs, on constant pressure surfaces between 100 to 4.6 mb.

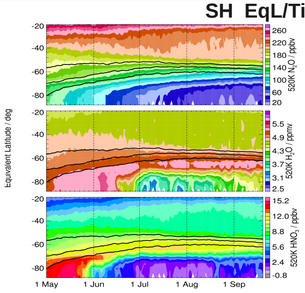
- Much smaller NH Tnat areas indicate that temperatures are almost always higher than in SH. NH temps drop below the ice PSC threshold infrequently (see Tmin plots).
- GEOS-5 & MLS data show larger areas of low temperatures consistent with lower minimum temps shown at left.
- NCEP/NCAR Reanalysis (REAN) shows smaller areas (higher temps). This has been previously documented and is related to known limitations in this data assimilation system. Also notice the lower pressure cap at 10mb. For these reasons, REAN is not recommended for strat studies.
- NH plots show the signature of a stratospheric sudden warming (SSW) in late Dec 2011, and a strong, prolonged SSW in late January 2012.

Summary and Future Work

- Stratospheric temperature diagnostics are important indicators for evaluating the severity of polar winters and the susceptibility to conditions that lead to ozone loss at the poles.
- The availability of many meteorological datasets with temperature products that span multiple years allows for direct comparisons between measurements (the Aura Microwave Limb Sounder, MLS), operational data assimilation systems (GEOS-5, NCEP, UKMO), and reanalysis data sets (ERA-Interim, MERRA, NCEP/NCAR Reanalysis).
- The temperature diagnostics shown here indicate persistent biases between different analyses, with the lowest temperatures seen in GEOS-5 data, and the highest temperatures seen in the REAN dataset.
- Our comparison of diagnostics related to polar processing is being extended to examine differences in the representation of the polar vortex (such as potential vorticity gradients) and other dynamical fields.
- Intercomparisons in reanalyses of polar processing diagnostics will be part of S-RIP (SPARC-Reanalysis/Analysis Intercomparison Project).

- These diagnostics are also used as part of the routine inspection of MLS data in relation to meteorological conditions.
- The current Antarctic winter can be described as follows:
  - Temperatures, especially at higher altitudes, have been higher than in most previous SH winters.
  - Consistent with this, active chlorine values in the polar vortex are lower.
  - As expected from the above conditions, there has been less ozone destruction relative to most of the past SH winters.

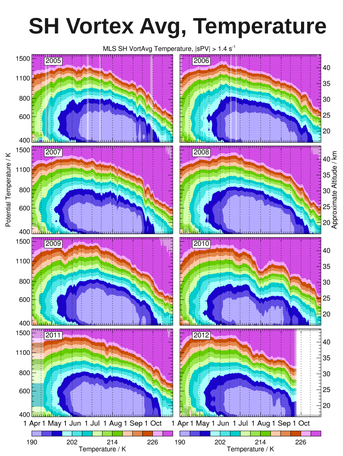
SH EqL/Time Fields



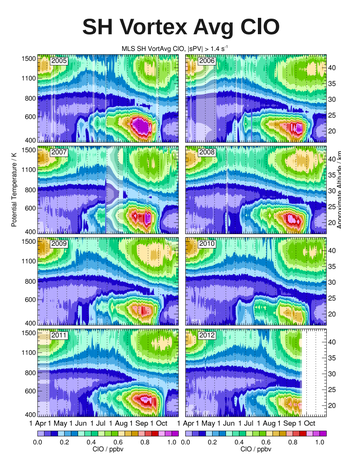
- Decreasing N_2O reflects confined descent within the polar vortex.
- Low H_2O and HNO_3 values within the polar vortex indicate extensive PSC activity.
- The strong anticorrelation between HCl and ClO is consistent with the conversion of chlorine from reservoir to active forms via reactions on the surfaces of PSCs.
- Decreasing ozone within the vortex, beginning in late July, is a signature of chemical ozone destruction.

The above plots show equivalent latitude time series of selected trace gases measured by MLS during the 2012 Antarctic winter at the 520K potential temp level. Potential vorticity contours representing the vortex edge region are overlaid in black.

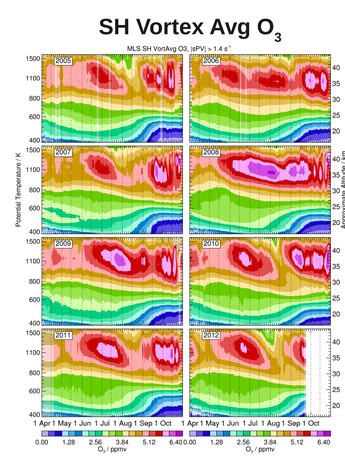
SH Vortex Avg, Temperature



SH Vortex Avg ClO



SH Vortex Avg O_3



These plots show Temperature, ClO and Ozone measured by MLS, averaged within the vortex, for the past eight Antarctic winters.

- Temperatures in 2012, especially at the higher altitudes shown, have been higher than usual for the SH; consistent with this, ClO values are lower than during most other SH winters.
- Consistent with slightly higher temperatures and less chlorine activation, ozone decreases thus far in 2012 are somewhat less than those seen in most previous years.

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Contact Information
Zachary Lawrence
E-mail: zlawrenc@nmt.edu